



NewLambda *Technologies*

High-Brightness Source Collector Module for EUV Mask Metrology

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NewLambda Technologies

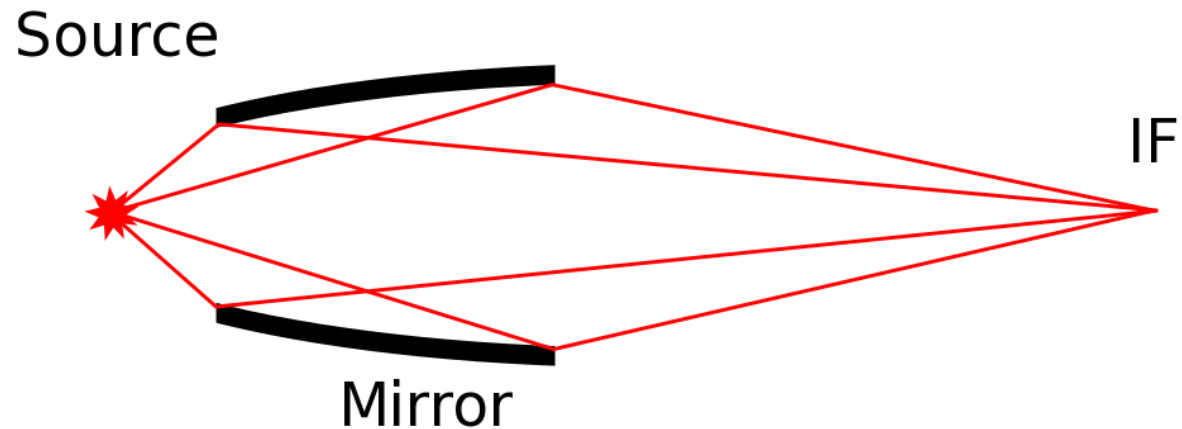
- Spin out from UCD School of Physics, Ireland
- Developing VUV, EUV and Soft X-ray sources
- Applications
 - Metrology
 - Surface analysis
 - Microscopy

Mask Metrology Source Status

Parameter	Industry Target Value*		
	AIMS	Blank	Pattern
Brightness (W/mm ² sr)	30-100	>80	>40
Etendue (mm ² sr)	5e-4	4e-3	1.5e-2
Position Stability (of FWHM)	3%	3%	3%
Size Stability	3%	3%	3%
Energy Stability	<3%	<3%	<3%-
Homogeneity	<5%	<5%	<5%
Operating time	100	100	100

* EUVL Symposium, 2011

NLT SoCoMo Concept



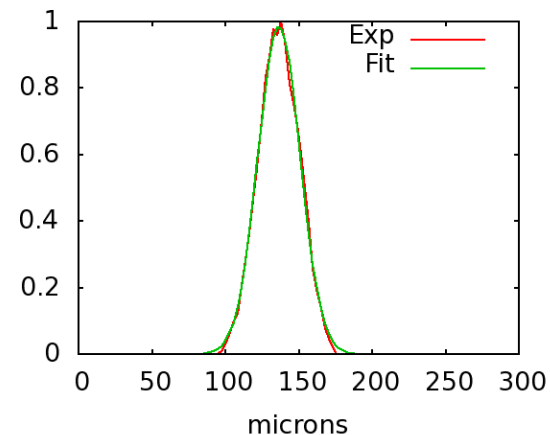
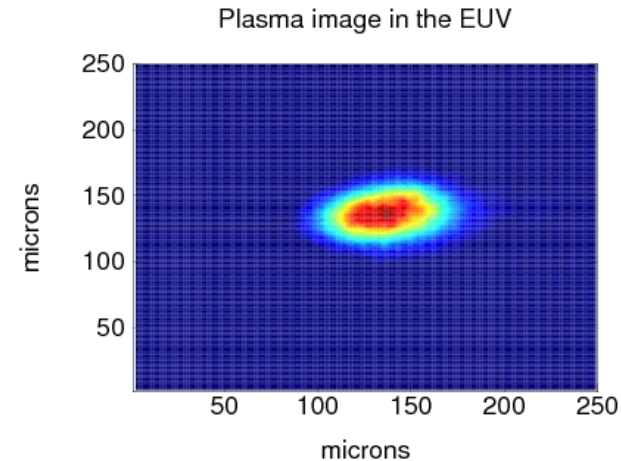
- Liquid Metal LPP source
- Liquid Metal Collector Mirror
- Small Etendue
- Clean, High Brightness IF

NLT Source

- LPP (Nd:YAG 125W, 25 mJ per pulse, 5 kHz)
- Proprietary liquid metal mixture as target
- Current status:
 - ~1000 hours total operation (since Nov. 2011)
 - Brightness = $80 \text{ W/mm}^2\text{sr}$
 - (Brightness calculated using the Carl Zeiss method)
 - 24 hours continuous
 - Roadmap to $>750 \text{ W/mm}^2\text{sr}$

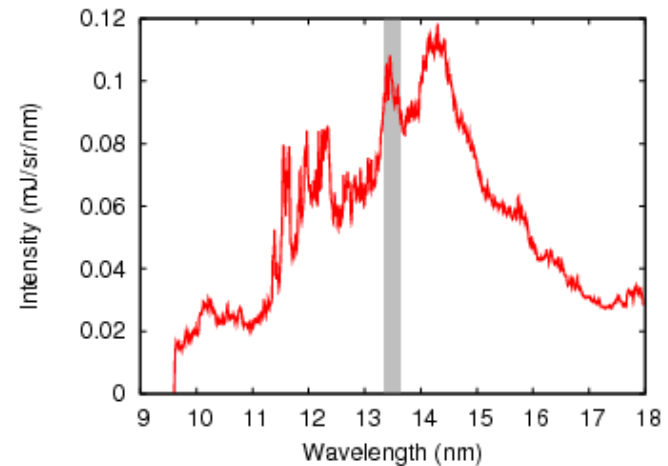
Source Imaging

- Imaged using multilayer concave mirror
- 10 shots per frame
- 34 x 55 micron spot measured
- Gaussian fit

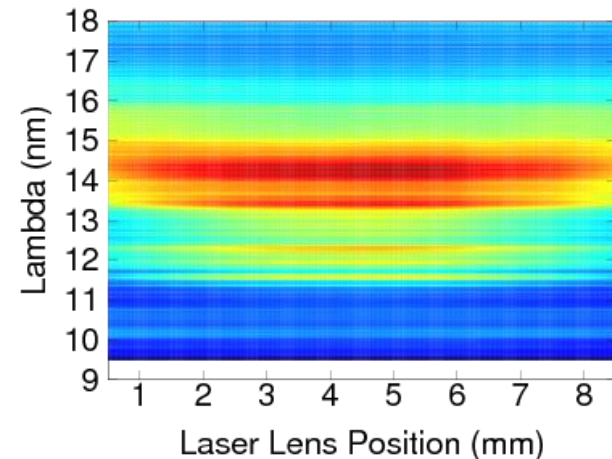


Source Spectra

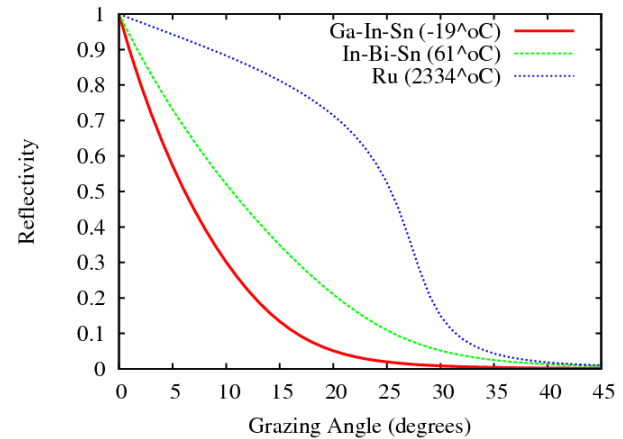
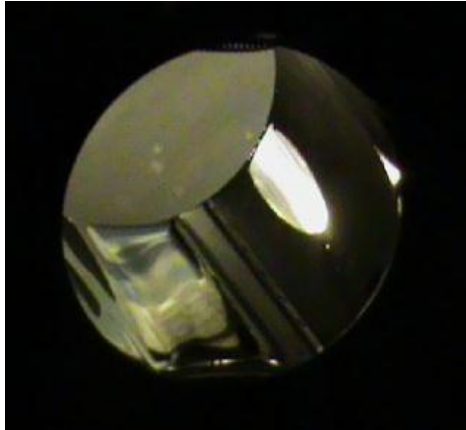
- Nd:YAG, 17 mJ per pulse, 1 kHz
- Viewed at 45°
- CE > 1% measured



1000 Hz



The Liquid Metal Collector



Collector design example:

Tin-based coating

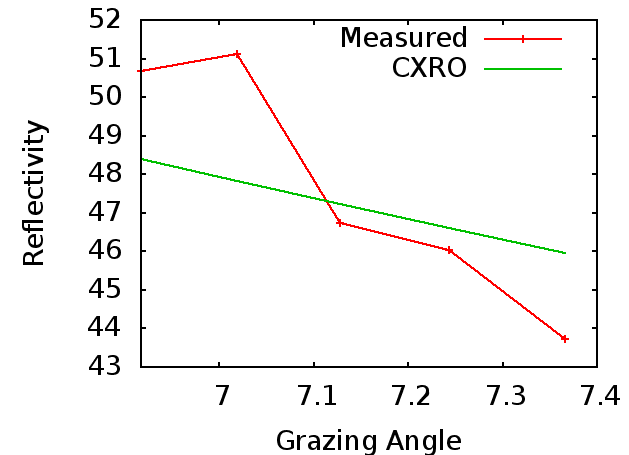
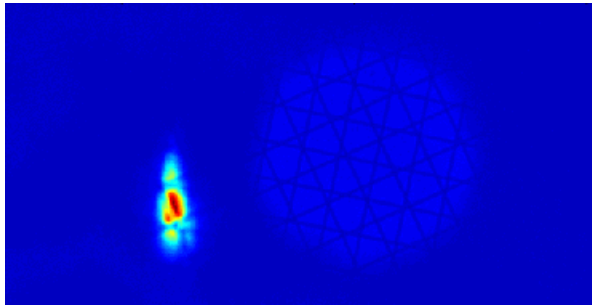
Ellipsoid Shape

Length = 100 mm

Large Diameter = 40 mm

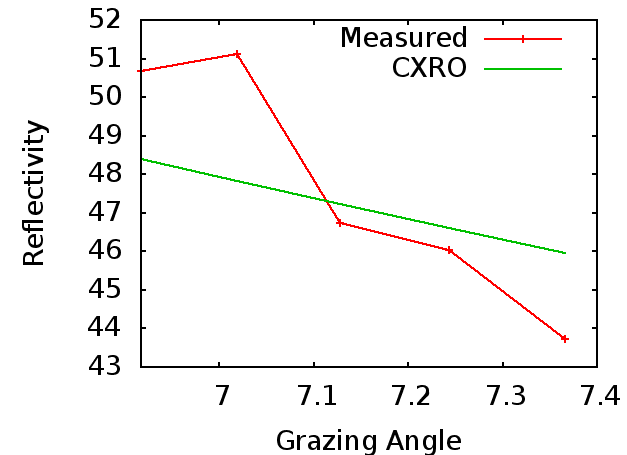
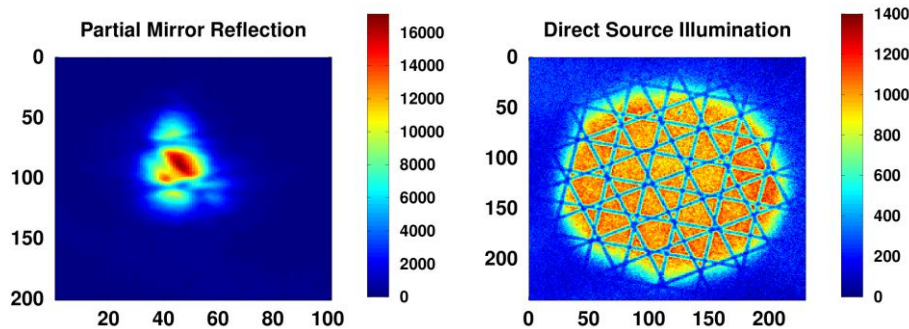
Predicted Collection ~ 3%

Liquid Metal Reflectivity



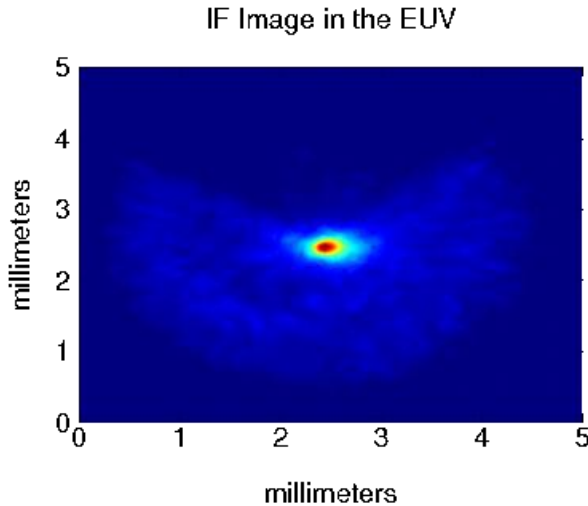
- Partial Mirror reflectivity V's Direct source illumination
- Reflectivity measured similar to CXRO

Liquid Metal Reflectivity

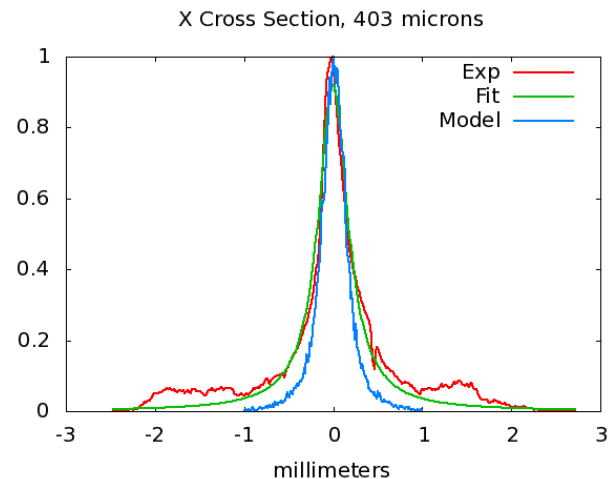
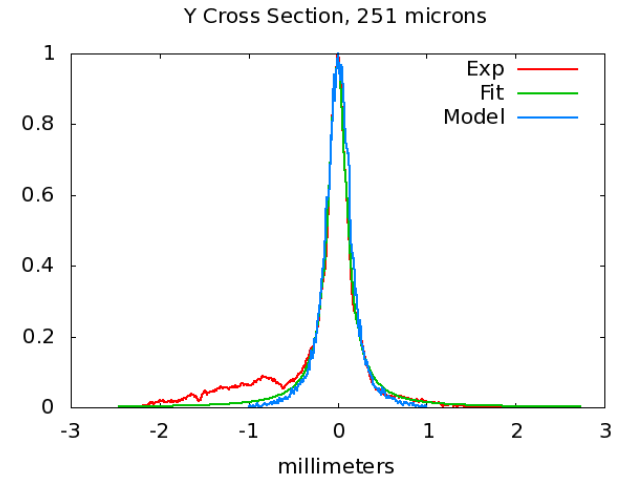


- Partial Mirror reflectivity V's Direct source illumination
- Reflectivity measured similar to CXRO

Intermediate Focus Imaging



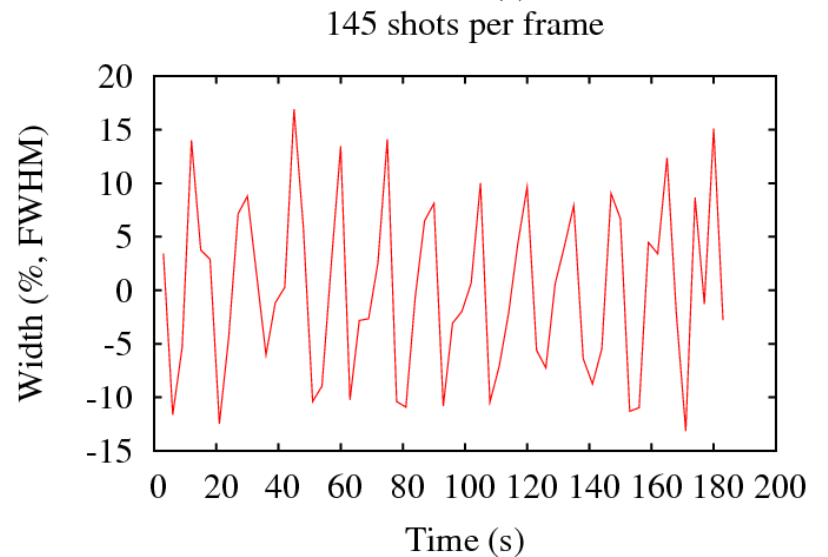
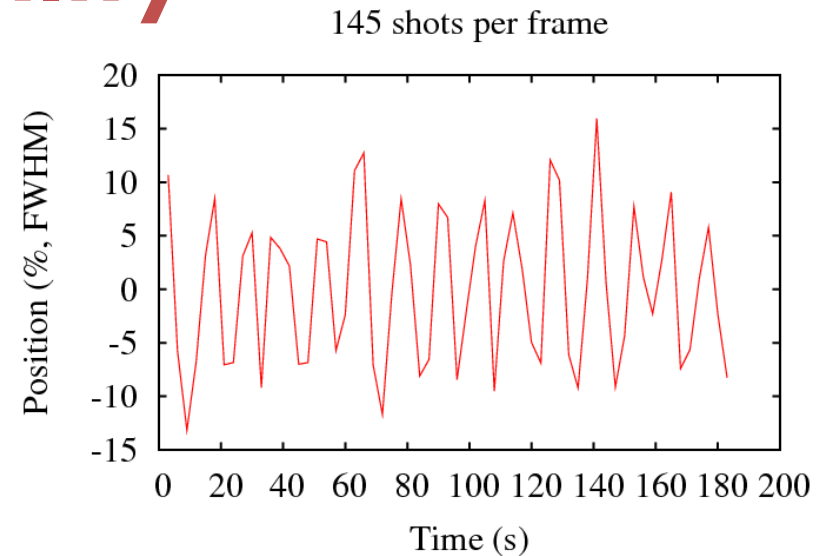
- Single Shot Imaging
- Lorentzian fit
- Zemax Modeled
- IF spot size $250 \times 400 \mu\text{m}$



IF Stability

Position

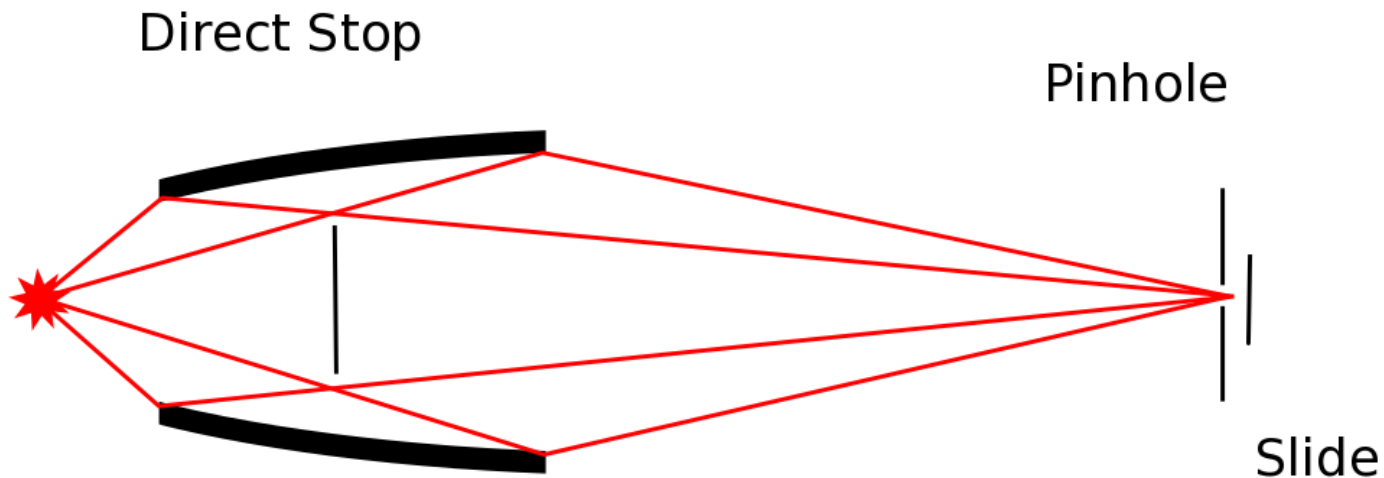
- Measured $\sigma = 7\%$
- Required $\sigma = 3\%$



Size

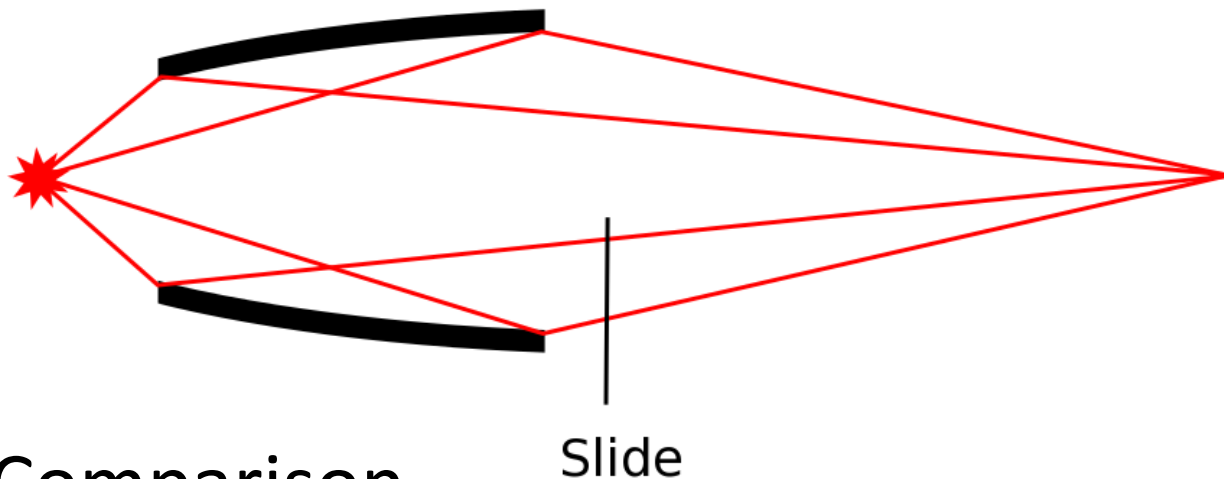
- Measured $\sigma = 8\%$
- Required $\sigma = 3\%$

IF Debris Measurement



- 1 mm aperture at IF
- One direct path baffle
- No debris mitigation
- Glass slide behind 1 mm aperture

IF Debris Measurement

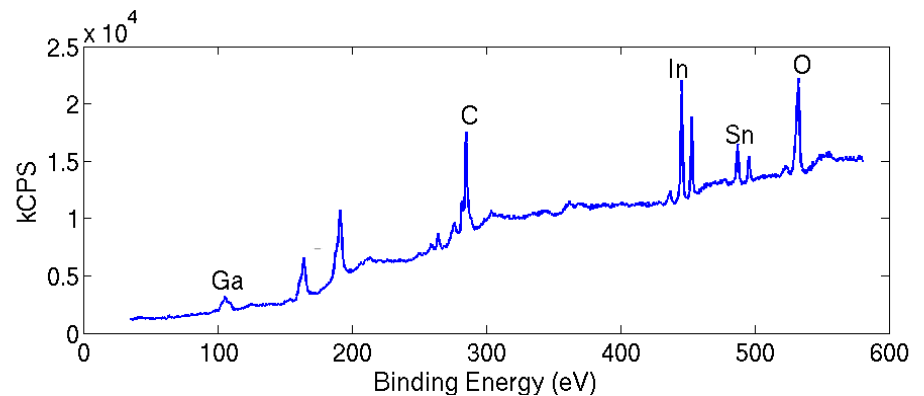
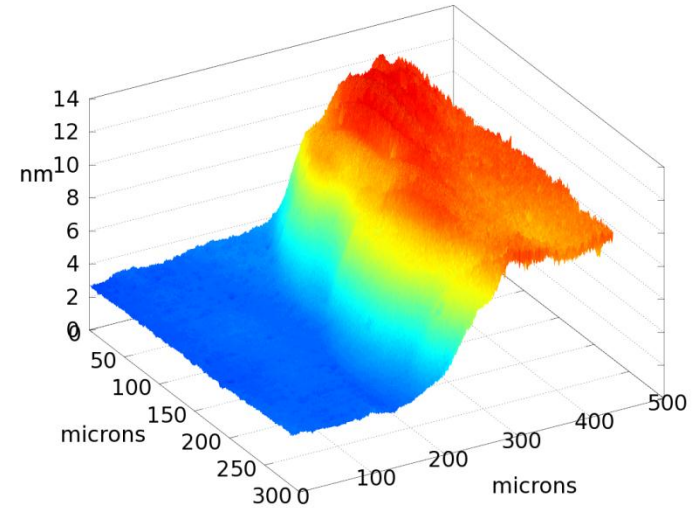


For Comparison

- Glass slide accepting direct source debris

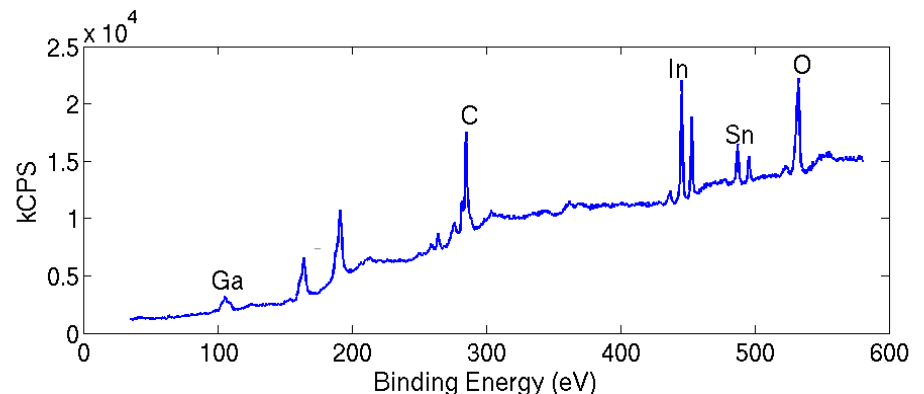
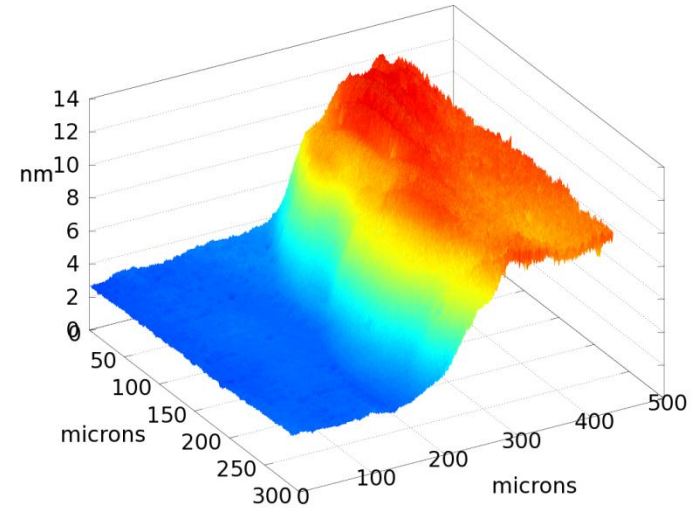
IF Debris Results

- 13 nm of material/hour
- No particulates
- XPS compositional analysis
 - 60% C
 - 26% O
 - 14% Liquid Metal



IF Debris Results

- 13 nm of material/hour
- No particulates
- XPS compositional analysis
 - 60% C
 - 26% O
 - 14% Liquid Metal
- 10's of microns directly from the source



NLT SoCoMo



- High Brightness LPP
- Clean IF
- Stand Alone Unit
- 1 m x 1 m x 1.2 m

Mask Metrology SoCoMo Status

Parameter	Industry Target Value			NewLambda
	AIMS	Blank	Pattern	Current Prototype
Brightness (W/mm ² sr)	30-100	>80	>40	80
Etendue (mm ² sr)	5e-4	4e-3	1.5e-2	<5e-4 (5% Uniformity)
Positional Stability	3%	3%	3%	7%
Size Stability	3%	3%	3%	8%
Energy Stability	<3%	<3%	<3%-	9%
Homogeneity	<5%	<5%	<5%	<5%
Operating time	100	100	100	>1000 total 24 continuous

Future Plans

- Upgrade Laser to 300 W
- Improve source & IF stability
- Optimising Liquid Metal recipe, (CE & Reflectivity)
- Extend measured operation time

Acknowledgements



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Thank you for listening